

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

12.07.2006

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| Applicant's or agent's file reference: P2550PC00/KH | FOR FURTHER ACTION See Form PCT/IPEA/416 | |
| International application No. PCT/FI2005/050139 | International filing date (day/month/year) 29-04-2005 | Priority date (day/month/year) 29-04-2004 |
| International Patent Classification (IPC) or national classification and IPC See Supplemental Box | | |
| Applicant: Nokia Corporation et al | | |

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

a. ☒ (sent to the applicant and to the International Bureau) a total of 5 sheets, as follows:

☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70:16 and Section 607 of the Administrative Instructions).

☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒ Box No. I Basis of the report

☐ Box No. II Priority

☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

☐ Box No. IV Lack of unity of invention

☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

☐ Box No. VI Certain documents cited

☐ Box No. VII Certain defects in the international application

☐ Box No. VIII Certain observations on the international application

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| Date of submission of the demand 16-02-2006 | Date of completion of this report 10-07-2006 |
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Form PCT/IPEA/409 (cover sheet) (April 2005)

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2005/050139

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Cover sheet

International patent classification (IPC)

G06T 3/40 (2006.01)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2005/050139

Box No. I Basis of the report

1. With regard to the language, this report is based on:

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:
- ☐ international search (Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (Rule 12.4(a))
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on (replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):

- ☒ the international application as originally filed/furnished
- ☐ the description:
- pages 1 - 14 as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☒ the claims:
- pages _____ as originally filed/furnished
- pages* 16 - 20 as amended (together with any statement) under Article 19
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☒ the drawings:
- pages 1/1 - 12/12 as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/FI2005/050139

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | |
|-------------------------------|---------------------|-----|
| Novelty (N) | Claims: <u>1-16</u> | YES |
| | Claims: _____ | NO |
| Inventive step (IS) | Claims: <u>1-16</u> | YES |
| | Claims: _____ | NO |
| Industrial applicability (IA) | Claims: <u>1-16</u> | YES |
| | Claims: _____ | NO |

2. Citations and explanations (Rule 70.7)

Relevant documents cited in the International Search Report:

D1: EP 0561417 A1
D2: US 6714692 B1
D3: US 20010048772 A1
D4: EP 0597793 A2

The applied invention relates to a method and apparatus for downscaling digital colour images. The method uses an area of pixels of the input image in order to calculate weighted sums for each area. The calculated weighted sums are then corrected by a scaling factor. In order to achieve efficient memory handling, the input colour image is read only once and the calculated weighted sums are formed parallel in line memories for each colour component.

Referring to claims 1-16:

D1-D3 disclose methods for scaling digital images. If only greyscale/black and white images are considered, the achieved effect (a downscaled image matrix) when executing any of the methods according to D1-D3 is the same as the effect obtained when executing the method according to the claimed invention. However, the invention according to claims 1-16 concerns colour images, which is not an issue in D1-D3. Consequently, D1-D3 fail to suggest means for achieving efficient memory handling when downscaling colour images. Hence, the downscaling methods disclosed in D1-D3 do not include means for downscaling a digital colour image, where a colour image matrix is read only once and calculated weighted sums are formed parallel in line memories for each colour component.

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: BOX V

D4 discloses a method for downscaling digital colour images. The result obtained when executing the method according to D4 is the same as the result obtained from the invention according to claims 1-16. However, when considering the memory handling the two methods differ in the way the weighted sums/coefficients are calculated. According to the invention disclosed in claims 1-16, an area coefficient is calculated and the input colour image matrix is only read once, which means that downscaling is performed simultaneously in vertical and horizontal directions. D4, on the other hand suggest a method where a coloured image matrix is scaled twice, first in the vertical direction, and then said vertically scaled image matrix is scaled in the horizontal direction, which leads to a larger number of calculations involving the weighted coefficients by comparison with the invention disclosed in claims 1-16.

In view of the aforementioned, the invention according to claims 1-16 is novel and is considered to involve an inventive step. The invention is industrially applicable.

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1AP9/Rec'd PCT/PTO 15 SEP 2006 16 -02- 2006

Claims

1. A method for downscaling a digital coloured matrix image by selected ratios M_2/M_1 and N_2/N_1 , in which the matrix image includes N_1 rows, each row including M_1 pixels, so that the values of the pixels form the matrix and the pixels of different colours form the selected format, and in which scaling is used to form an output matrix, of a size $M_2 \times N_2$, the pixels corresponding to sub-groups of the original matrix, in such a way that $M_2 \leq M_1$ and $N_2 \leq N_1$, and from the values $\text{Input}(j,i)$ of which pixels (i,j) the value $\text{Output}(l,k)$ of each output pixel (k,l) of the output matrix is calculated, characterized in that the coloured matrix image is read only once and the weighted sums of the values of the same-colour pixels (i,j) of the matrix image in the area of each output pixel (k,l) is formed parallel in line memories ($\text{Buffer}[0]$, $\text{Buffer}[1]$) arranged for each colour, the weighting coefficient being the dimension share of the pixel (i,j) in the area of the output pixel (k,l) and each weighted sum is corrected by a scaling factor ($f \times M_2/M_1 \times N_2/N_1$).

2. A method according to Claim 1, characterized in that the scaling is carried out in one dimension (x) at a time, by calculating the intermediate sums $\text{Outx}(l)$ of this dimension in the memory location ($\text{Data}[0]$, $\text{Data}[1]$) by forming the weighted sum of the intensities of the pixels of this dimension, the weighting coefficients being the proportion of each source pixel (i,j) in this dimension's output pixels (k,l) and by transferring the sum finally to the line memory ($\text{Buffer}[0]$, $\text{Buffer}[1]$), to each elementary unit (l) of which the intermediate sums $\text{Outx}(l)$ of the output pixel (k,l) of the corresponding column (k) are calculated.

3. A method according to Claim 2, characterized in that the calculation is performed by using alternating pairs of memory locations ($\text{Data}[0]$, $\text{Data}[1]$) and alternating pairs of line memory ($\text{Buffer}[0]$, $\text{Buffer}[1]$), in such a way that:

- in the case of a part pixel (i,j) , the initial part intensity of the following output pixel $(k+1,l)$ is also always calculated to a second memory location, in which the summed intensity of the subsequent index $(k+1)$ is in turn collected, and

- in the case of a part row, the intensity value of each pixel (i,j) is divided between both memory locations, in proportion to how the pixel covers the output pixel (k, l) and the following output pixel $(k, l+1)$ in the corresponding dimension and is summed over the length of the output pixel and each first sum is stored in the next row buffer in turn and

the second sum is stored in the second row buffer $((l+1)\text{mod}2)$, in which the sums of the following output row $(l+1)$ are begun to be collected.

4. A method according to any of Claims 1 – 3, characterized in that the output image is moved relative to the input image, in such a way that part of the information of the edge pixels of the input image is left unused and correspondingly, at the opposite edge, additional information is extrapolated to the input pixels.

5. An apparatus for downscaling a digital coloured matrix image by selected ratios $(M_2/M_1 \text{ and } N_2/N_1)$, which the apparatus includes an application memory for storing and processing the scaled matrix image, a central processing unit (CPU), a program memory area and a program stored into for performing the processing, and in which the matrix image includes N_1 rows, each row including M_1 pixels, so that the values of the pixels form the matrix and the pixels of different colours form the format, and in which the pixels of the output matrix, of a size $M_2 \times N_2$, formed by the scaling, correspond to sub-groups of the original matrix, from the values of which pixels the mean value of each pixel of the output matrix is calculated by calculating the sum of the values and dividing it by the scaling factor $(M_2/M_1 \times N_2/N_1)$, characterized in that the apparatus is arranged to read the coloured matrix image only once and to process the input pixels (k,l) individually, in such a way that the said sum of the values is formed parallel in line memories (Buffer[0], Buffer[1]) arranged for each colour weighted from the values of the same colour matrix-image pixels (i,j) in the area of each output pixel (k,l) , the weighting coefficient being the dimension proportion of the pixel (i,j) in the area of the output pixel (k,l) .

6. An apparatus according to Claim 5, characterized in that the memory area includes four memory locations (Data[0/1][0/1]) for each colour and two line memories (Buffer[0], Buffer[1]) for each colour and that the apparatus is arranged to perform scaling in one dimension (x) at a time, by calculating the intermediate sums $\text{Outx}(l)$ of this dimension into a memory location (Data[0], Data[1]) by forming the weighted sum of the intensities of the pixels of this dimension, the weighting factors being the proportion of each source pixel (i,j) in the output pixels (k,l) of this dimension and to transfer the sum finally to the line memory (Buffer[0], Buffer[1]), the intermediate sums Outx corresponding to one calculated output pixel row (l) being arranged in each elementary unit (k) .

7. An apparatus according to Claim 6, characterized in that it includes an alternating pair of memory locations (Data[0], Data[1]) and an alternating pair of line memories (Buffer[0], Buffer[1]), to which address means are linked, which are arranged using the least significant bit of the functioning binary-form index (k, l), in such a way that

- in the case of a part pixel (i,j), the initial part intensity of the following output pixel (k+1,l) is also always calculated into a second memory location, in which the sum intensity of the following index (k+1) is in turn collected; and
- in the case of a part row, the intensity value of each pixel (i,j) is divided between both memory locations, in proportion to how the pixel covers the output pixel (k, l) and the following output pixel (k, l+1) in the corresponding dimension, and the part values are summed and stored over the length of the output pixel in the line memories (Buffer[0], Buffer[1]).

8. An apparatus according to any of Claim 5 - 7, characterized in that the apparatus is integrated in connection with the camera sensor of the camera.

9. An apparatus according to Claim 8 and including a host system, characterized in that scaling in one dimension is integrated in connection with the camera sensor of the camera and the scaling in the other dimension with the host system.

10. An apparatus according to Claim 6 or 7, characterized in that the apparatus includes a scaler component, in which there are separate processors (CPU) for scaling in each dimension.

11. An apparatus according to any of Claims 5 - 10, characterized in that the apparatus includes memory for the scaling operations of at least two output-image lines for each colour component.

12. An apparatus according to any of Claims 5 - 11, characterized in that the memory required in scaling is implemented in the processor (CPU).

13. An apparatus according to any of Claims 5 - 12, characterized in that the apparatus is arranged in a mobile terminal.

14. A method for downscaling a digital matrix image, by means of software, by selected ratios M_2/M_1 and N_2/N_1 , in a digital device, in which there is a scaling component including at least an input unit for bringing the input rows to the scaling component, a processor and memory for processing the data, and an output part from forwarding the processed data, and in which the matrix image includes N_1 rows, each row including M_1 pixels, so that the values of the pixels form the matrix and the pixels of different colours form the selected format, and in which the pixels of the output matrix, of a size $M_2 \times N_2$, formed by scaling, correspond to the sub-groups of the original matrix, in such way that $M_2 < M_1$ and $N_2 < N_1$, and from the values Input (j,i) of which pixels (i,j) the value Output (l,k) is calculated for each output pixel (k,l) of the output matrix, characterized in that:

- the coloured matrix image is read only once so that each input row is brought in turn, and each pixel is taken individually to the processor for processing,
- the weighting coefficient for each pixel is calculated in the area of the output pixel, the weighting coefficient depicting the part of the surface area of the pixel in the output pixel,
- the values of the pixels of the input row are summed in the area of each output pixel (k,l) according to a predefined sequence, in such a way that a weighted sum is formed parallel in line memories (Buffer[0], Buffer[1]) arranged for each colour and each sum is formed of the values of the same-colour matrix-image pixels (i,j) in the area of each output pixel (k,l) , and each weighted sum is corrected by a scaling factor $(M_2/M_1 \times N_2/N_1)$,
- the corrected sum is transferred out through the output part.

15. A method according to Claim 14, characterized in that the memory includes at least two pairs of memory locations (Data[0], Data[1]) for summing the intensities and two line memories (Buffer[0], Buffer[1]), and in which

- the relationship of the input line j to the output line l is defined and
- the intermediate sums Outx (i,l) in the selected dimension (x) are calculated to the memory location Data $[k \bmod 2]$ that is now in turn and the final part of the part pixel to the second memory location (Data $[(k+1) \bmod 2]$) and the sum is finally transferred to the line memory (Buffer[0], Buffer[1]), to each elementary unit (l) of

which the intermediate sums $\text{Outx}(i,l)$ of the output pixel (k,l) of the corresponding column (l) are calculated.

16. A method according to Claim 15, characterized in that

- 5 - the memory locations (Data[0], Data[1]) of the pair of memory locations and the line memories (Buffer[0], Buffer[1]) of the pair of line memories are addressed with the aid of an alternating function,
 - in the case of a part pixel (i,j) the initial part intensity of the following output pixel $(k+1,l)$ is always also calculated and is stored in the second memory location, in which the sum
 - 10 intensity of the index $(k+1)$ following in turn is collected, and
 - in the case of a part row, the intensity value of each pixel (i,j) is divided and stored in both memory locations in proportion to how the pixel and the following pixel $(k,l+1)$ cover the output pixel (k,l) in the corresponding dimension (y) , and are summed over the length of the output pixel and the first sum of each is stored in the line memory now
 - 15 in turn and the second sum in the second line memory $((l+1)\text{mod}2)$, in which the sums of the following output row $(l+1)$ are begun to be collected.

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